Thine was unstinted zeal, unchilled devotion,
While the blue realm had kingdoms to explore—
Patience, like his who ploughed the unfurrowed ocean,
Till o'er its margin loomed San Salvador.

Through the long nights I see thee ever waking,
Thy footstool earth, thy roof the hemisphere,
While with thy griefs our weaker hearts are aching,
Firm as thine equatorial's rock-based pier.

The souls that voyaged the azure depths before thee
Watch with thy tireless vigils, all unseen—
Tycho and Kepler bend benignant o'er thee,
And with his toy-like tube the Florentine—

He at whose word the orb that bore him shivered
To find her central sovereignty disowned,
While the wan lips of priest and pontiff quivered,
Their jargon stilled, their Baal disenthroned.

Flamsteed and Newton look with brows unclouded,
Their strife forgotten with its faded scars—
(Titans, who found the world of space too crowded
To walk in peace among its myriad stars).

All cluster round thee—seers of earliest ages,
Persians, Ionians, Mizraim's learned kings,
From the dim days of Shinar's hoary sages
To his who weighed the planet's fluid rings.

And we, for whom the northern heavens are lighted,
For whom the storm has passed, the sun has smiled,
Our clouds all scattered, all our stars united,
We claim thee, clasp thee, like a long-lost child.

Fresh from the spangled vault's o'erarching splendour,
Thy lonely pillar, thy revolving dome,
In heartfelt accents, proud, rejoicing, tender,
We bid thee welcome to thine earthly home.

The Rev. James Freeman Clarke in saying a word in honour of "our friend, the eminent astronomer, who is our guest to-night," remarked that—

"We are on the verge of still greater discoveries than any yet made, and our own country is prepared to do its full part in the work. When the Russian Government wishes for a better telescope than any now in Europe, it sends to Cambridgeport to get it. Mr. Rutherfurd invents an instrument which gives us the best photographs of the moon ever made. The Washington Observatory discovers the two satellites of Mars. Prof. Langley, in the midst of Pittsburg smoke, has made observations with instruments of his own invention, with an account of which he is now arousing great interest among the men of science of England. Dr. Peters, of Clinton, N.Y., and Prof. Watson, of Ann Arbor, have been the chief discoverers of the asteroids. Prof. Young and Harkness first gave, in 1869, the true theory of the solar corona. The two Bonds, at the Cambridge Observatory, have taken rank among the chief astronomers of our time. Our friend, Prof. Pickering, amid all his other labours, has invented instruments of precision by which the light of the stars can be measured with accuracy. And now we welcome home Dr. Gould, who has given long years of labour in a far-off land, away from home and friends, to complete his great work of a catalogue of the southern stars. To him and to his noble wife who shared his labours, sustained his courage, was his companion in his sacrifices, we give our thanks and our love to-night. We sympathise with him in that great loss, and we thank God with him that he and she had this great opportunity, and that they were able to share together, side by side, the consciousness of doing a work which will never be forgotten."

Other tributes were paid to the work of Dr. Gould by Prof. Lovering, of Harvard, Prof. Pickering, of Harvard Observatory, Dr. William Everett, Prof. W. A. Rogers, of Harvard. The last-named said that there is no exaggeration in the statement that the work which Dr. Gould has accomplished during the past thirteen years is without a parallel in the annals of astronomy.

"First of all it needs to be said that in 1870 there was no Cordoba Observatory. I suspect, also, that it must be said that astronomers had at that time little faith in the fulfilment of plans which required that the Government of a South American Republic should persistently pursue, for a series of years, that wise, enlightened and liberal policy which has made the Argentine Republic a conspicuous example of the way in which a government may foster learning and research with the most encouraging results. I do not know of a better way to give a clear idea of the magnitude of this work than by comparing it with similar work done previous to 1872. There are in the northern heavens, between the north pole and a little distance below the equator, about 4500 stars visible to the naked eye. These stars have been observed with more or less regularity at various observatories since about 1750. Within the same limits there are about 95,000 stars as bright or brighter than the ninth magnitude, which are usually observed in narrow belts or zones, and such stars are usually referred to as zone stars. The bright stars are common to nearly all general catalogues, but the positions of the fainter stars depend for the most part on two or three separate observations. Dr. Gould has formed two catalogues since 1872—a general catalogue of stars extending to the south pole, containing 34,000 stars, and a catalogue of zone stars, numbering 73,000. These two catalogues represent about 250,000 separate observations. It is stated in one of the printed volumes that the chronographic register of the transits, the pointing of the telescope for declination, and the estimation of the magnitude have all been done by Dr. Gould personally. The distinct and separate observations involved in this work must certainly exceed 1,000,000. I suppose there must be several gentlemen present who have a realising sense of what a million really means, but for myself I commonly say that it seems to me to be a very large number. Having made less than 50,000 observations during the time covered by Dr. Gould's observations, can you wonder that this work, which seems so far beyond the limit of human endurance, is at once my amazement, my admiration, and—I must add—my despair? The whole number of stars in the two Cordoba catalogues is nearly three times as great as in any single catalogue thus far constructed; and it must be remembered in this connection, that the great catalogues of Lalande, of Bessel, of Argelander, and of Schjellerup, represent the labours of a life-time. The total number of stars in all catalogues formed previous to 1870, is about 260,000 as against the 105,000 stars in the Cordoba catalogues. But there is another comparison which may be made, which will reveal yet more clearly, not only the magnitude of the work which Dr. Gould has now finished, but the intense energy with which it has been pushed to completion. Since 1869 a confederation of fourteen observatories, situated in different parts of the world, has been engaged in the accurate determinations of the positions of the 100,000 stars to the ninth magnitude, in the northern heavens. Up to 1882 a total of about 346,000 observations had been made. Considerable progress had been made in this work before Dr. Gould left this country for South America. His work, involving two-thirds as many observations as all others combined, is completed, and is all in the hands of the printer, while the actual formation of the catalogue to be issued under the direction of the Astronomische Gesellschaft can hardly be said to have been begun."

TELPHERAGE

On Saturday, October 17, a special train from Victoria conveyed a party of about 200 guests, among whom were many leading electricians, engineers, and other well-known men of science, to Glynde, in Sussex, to witness the ceremony of the opening of the first telpher line erected in this country. The ceremony was performed by the Viscountess Hampden, and was of an exceedingly simple character; on lifting a small box containing a present which the Chairman of the Company invited her ladyship to accept, electric communication was instantly established between the dynamo in the engine-house and the telpher line, and a train loaded with clay at once began to move up an incline towards the Glynde Railway Station, amidst the applause of the assembled spectators. Whether this ceremony, which brought so many distinguished visitors down to Lord Hampden's estate on Saturday, is the inauguration of a great commercial enterprise is beyond our province to inquire; but it is unquestionable that the slight flash seen when Lady Hampden lifted the little box lying on the table in front of the engine-house marked the beginning of a new departure in electro-technology.

Telpherage has been defined as the transmission of goods and passengers by means of electricity without driver, guard, signalmen, or attendants. The conception of propelling electrically a continuous stream of light trains along an elevated *single* rail or rope was due to the late Prof. Fleeming Jenkin, but, as stated by him in his introductory address at the University of Edinburgh, he did not see his way to carry this conception into practice until he read the account of the electrical railway exhibited by Professors Ayrton and Perry at the Royal Institution in 1882, when the idea of subdividing the rubbed conductor into sections and providing an *absolute block* for automatically preventing electric trains running into one another was first publicly described. A combination between these three gentlemen was then effected, which led ultimately to the formation of the Telpherage Company and to the series of experiments, lasting for over two years, on actual telpher lines erected at Weston in Hertfordshire, on the estate of Mr. Pryor, the chairman of the company. Various devices were worked out forming the subject of patents, which, together with the other patents of Professors Fleeming Jenkin, Ayrton, and Perry in telpherage, previously taken out, are possessed by the present Telpherage Company. At the commencement of this year matters had sufficiently advanced for the erection of commercial telpher lines, and as a tramway or road would have much interfered with the grazing and hay growing carried on in the fields at Glynde, and, as in addition these fields are under water during the winter, telpherage appeared to furnish the cheapest and most suitable mode of carrying the clay from the clay pits to the London, Brighton, and South Coast Railway. Consequently the Sussex Portland Cement Company decided to adopt this method of transport.

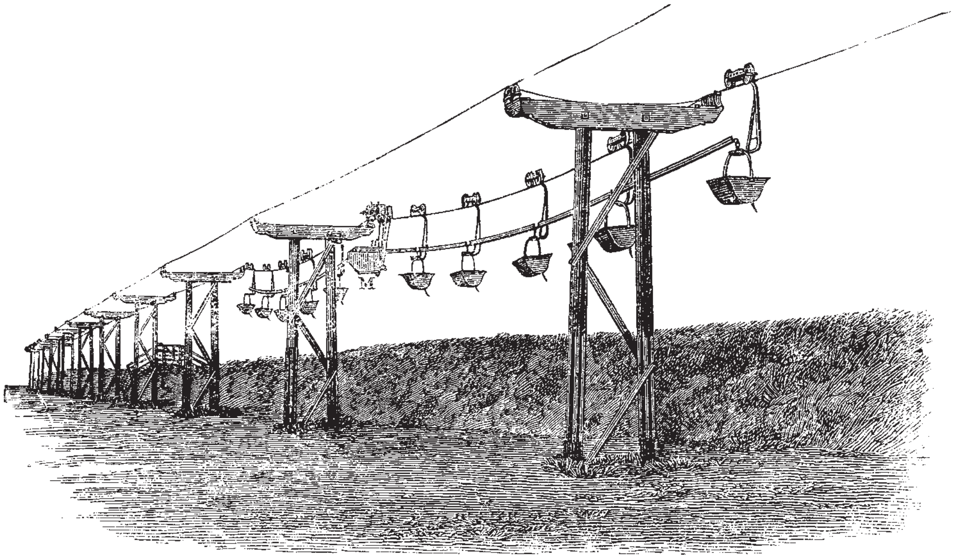

FIG. 1.

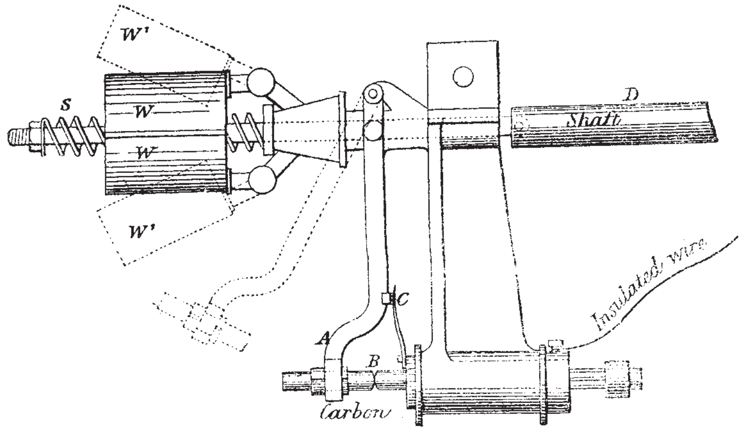

FIG. 2.

The line now opened is nearly a mile long, and composed of a double set of steel rods each 66 feet long, three-quarters of an inch in diameter, and 8 feet apart, supported on wooden posts standing about 18 feet above the ground, as seen in our illustration (Fig. 1), which is from a photograph taken of the line just before it crosses the stream. On the death of the late lamented Prof. Jenkin the construction of the Glynde telpher line was left for completion in the hands of Prof. Perry, who was then appointed the engineer to the company. The new line, it must be understood, is more than a mere experimental attempt. Although, as scientific men will appreciate, a new undertaking must necessarily involve much tentative experience, the programme carried out on Saturday marked the final result of the experiences gained by the constructors under the direction of Prof. Perry, and the Company are now regularly delivering clay at the Glynde Railway Station for the use of the Newhaven Cement Company at a price, as we are informed, of 7½*d.* per ton.

The garlanded train which passed along the steel rod-way on Saturday consisted of an electric locomotive, seen in Fig. 1 at about the middle of the train and propelled by the electromotor M, and ten skeps, or buckets, which hang by their travelling wheels from the steel line. Each skep weighs 101 lbs., and carries 250 to 300 lbs. of dry clay, and, by distributing these evenly and somewhat widely apart, the strain on the steel line is small although the total weight of the train and clay is about two tons, also as equal weights are simultaneously ascending and descending similar inclines on the several spans the effect of the sag on the mechanical resistance of the train is neutralised, and little more resistance is experienced than in hauling a similar train along a rigid road. The rate of travelling is 4 to 5 miles an hour about two electric horse-power only being necessary to be furnished at the engine-house to propel the train at this speed, and the train is under the control of a workman, who, by touching a key, can start, stop, or reverse the train at pleasure. On the arrival of each telpher train at the railway siding the clay is emptied into the railway waggons by the skeps being tipped over, this being effected either by a man touching with a pole the handles which are seen in Fig. 1 hanging down from the skeps, or automatically by these handles coming successively into contact with a wooden arm padded with india-rubber which is made to stand out from the post where it is desired the clay is to be emptied. One train will deliver the minimum amount of clay (150 tons per week) required by the Cement Company, but, if necessary, twenty trains can be run on the line without fear of a collision as an absolute automatic block is provided, and the trains are, moreover, governed automatically so as to run up or down an incline at the same speed.

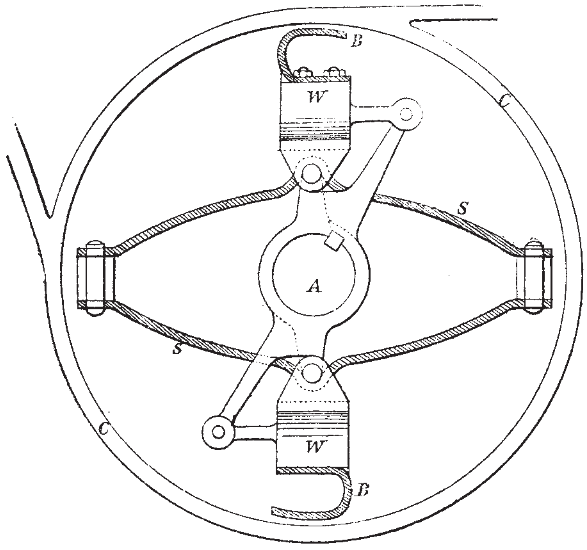

Fig. 3.

This automatic governing of the speed of the train is effected in two ways—first, there is a governor attached to each motor, which interrupts the electric circuit, and cuts off the power when the speed becomes too high; secondly, there is a brake which is brought into action should the speed attain a still higher value. To avoid the formation of a permanent electric arc when the circuit is broken, the governor (Fig. 2) is so arranged that the diverging weights are in *unstable* equilibrium between two stops—they fly out at about 1700 revolutions per minute of the motor, and fly back at about 1600. When the circuit is closed the current is conveyed across the metallic contact at C. When the weights W W fly out this contact is first broken, but no spark occurs because a connection of small resistance is continued at B between the piece of carbon and a piece of steel, which being pressed out by a spring follows the carbon for a short distance as the arm A begins to fly out. This contact is next broken, producing an electric arc, which however is instantly extinguished by the lever A flying out to the dotted position. The brake is shown on Fig. 3, and consists simply of a pair of weights, W W, which at a limiting speed greater than 1700 revolutions per minute of the motor press the brake blocks B B against the rim C C, and introduce the necessary amount of retarding friction. In practice, however, with the gradients such as exist at Glynde, and which do not exceed 1 in 13, the economic method of automatically cutting off the power with the governor is all that is necessary to control the speed of the train; the brake rarely coming into action. With steeper gradients, however, the brake would undoubtedly be very useful.

The current required is 8 amperes per train, this current being measured by an ammeter in the engine-house, and by roughly timing the intervals when no current is being given to a train, that is, when the governor is acting, the particular hill the train is descending can be electrically determined by practice, and so the progress of a train along the telpher line can be approximately followed by simply watching the ammeter in the engine-house. The electric current is supplied from a 200-volt dynamo driven by a steam-engine, and controlled by a Willans electric governor which automatically varies the speed of the engine and dynamo so as always to keep the electromotive force at 200 volts whatever be the number of trains running; hence the starting or stopping of one telpher train in no way affects the speed of the remainder. It is obvious that water-power or any other source of power can be used where available, even when the source of power is at a considerable distance from the line. By means of compensating gear the tension of the line is so regulated that it can never exceed 2¼ tons on each rod, whatever the temperature, and for straining the steel rods, when first erected, up to the right tension an ingenious arrangement has been devised during the construction of the line of vibrating them and determining the strain on a rod from the number of vibrations it makes per minute.

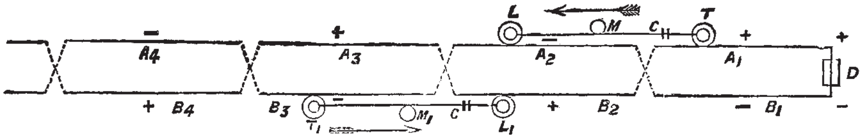

Fig. 4.

The way in which a single wheel track is made to serve for one train, or rather two wheel tracks for two trains, instead of the necessity of having four wheel tracks for two trains, as in the ordinary electric railways, is seen from Fig. 4. D is the dynamo maintaining two long conductors permanently at different potentials indicated by the signs + and − of each section. The wheels L and T of one train, and L_1 and T_1 of the other, are insulated from their trucks and joined by a conductor attached respectively to the terminals of the motor M and M_1. A current consequently is always passing from a + section to a − section through each motor. Mechanically then each train is supported by what is practically one continuous steel rod, but in reality at the tops of the posts the rods are electrically subdivided into sections and joined across by insulated wires, one of which may be seen at the top of the posts in Fig. 1. The wires connecting the two skeps with the motor, shown in Fig. 4, are not seen in Fig. 1, as they were too thin to appear in the photograph from which this figure was taken. To prevent the metallic wheels of the skeps short circuiting the two sections as they cross the tops of the posts, there are insulated gap pieces, which may be seen in Fig. 1, at the tops of the posts where the steel rod is electrically divided.

Various devices have been tried for gripping the rod to obtain the hold necessary to enable the locomotive to haul the train, and these, with many ingenious plans of *nest gearing* for economically communicating the power given out by the very quickly revolving electro-motor to the much more slowly moving wheels of the telpher locomotive, formed the subject of Prof. Jenkin's lecture at the Society of Arts in the spring of 1884. Practically, however, it is found that for moderate inclines direct driving, with pitch chains, of two wheels with india-rubber treads gives a gravitation grip sufficiently large for satisfactory haulage; hence the expense of the locomotive, the complexity and wear and tear of its parts combined with the risk of its getting out of order have been all most materially reduced during the last twelve months.

As the result of the experience gained in the construction of the Glynde line, it is estimated that a similar line could now be erected at short notice for a total cost of 1200*l*., including engine, dynamo, permanent way, and five trains, with locomotives to carry 100 tons daily; the working expenses, including coal, attendance, and depreciation, being less than 3*d*. per ton per mile upon the material carried. A double line like that at Glynde, ten miles long, worked heavily, would carry material at a cost of 2*d*. per ton per mile, the skeps being empty on their return journey. The larger part of the original cost of the Telpher line is due to dynamos and rolling stock. This plant can be increased, as we are informed, in proportion to the work required, so that there is a very moderate increase of cost in the rate per ton per mile for a small traffic, as compared with a larger one. On the other hand, a line constructed for a small traffic will accommodate a much larger one with no fresh outlay on the line itself.

Leaving these facts and figures to speak for themselves, it now only remains to point out the advantages claimed for this system of electric carriage. In the first place the facility with which such a line can be run up and carried over uneven ground or across streams, high fences, and deep ditches, where an ordinary railway would involve serious expense, is sufficiently obvious. A Telpher line need not, as a railway necessarily does, impede the ordinary agricultural operations, but may be carried over fields and pasture lands with little inconvenience. The Telpher line is, moreover, in itself a source of power which can be simultaneously tapped at any desired points and made to assist in the work of agriculture, as the visitors on Saturday had an opportunity of witnessing when, by means of a motor connected with the line, a turnip-cutter was put into operation. The possibility of utilising natural sources of power like falling water, and of working the line at great distances from such sources will, as already stated, be evident to our readers. A special advantage claimed for the new system is the ease with which the trains can go round sharp curves without loss of power, since electricity, having no momentum, experiences no loss in going round a corner, whereas, with the overhead wire haulage system, as used in Spain and elsewhere, there is both considerable friction and great wear and tear of the running wire ropes where they go round sharp curves.

The constructors of the Glynde Line are careful to point out that the present line is far from perfect; unnecessary gradients have been introduced in order to show how the system can be carried over uneven land, and many other improvements have suggested themselves in the course of their experience, of which advantage would be taken in future undertakings. In face of these disadvantages, the success which marked Saturday's proceedings renders Telpherage, as a system, a very hopeful and cheap method of transference, and the Company is to be congratulated in having taken the first initiative step in this new application of electricity. That Telpherage will ever come into serious competition with the large railways is not intended, for the statement made by the Company is to the effect that the function of the Telpher line is not to compete with railways, but to do cheaply the work of horses and carts, light tramways, and the wire rope haulage system, and this, we think, it has a good chance of successfully accomplishing.

THE MELDOMETER

THE apparatus which I propose to call by the above name (μέλδω, to melt) consists of an adjunct to the mineralogical microscope, whereby the melting points of minerals may be compared or approximately determined and their behaviour watched at high temperatures either alone or in the presence of reagents.

As I now use it it consists of a narrow ribbon of platinum (2mm. wide) arranged to traverse the field of the microscope. The ribbon, clamped in two brass clamps so as to be readily renewable, passes bridgewise over a little scooped-out hollow in a disk of ebony (4 cm. diam.). The clamps also take wires from a battery (3 Groves cells), and an adjustable resistance being placed in circuit the strip can be thus raised in temperature up to the melting point of platinum.

The disk being placed on the stage of the microscope the platinum strip is brought into the field of a 1″ objective, protected by a glass slip from the radiant heat. The observer is sheltered from the intense light at high temperatures by a wedge of tinted glass, which further can be used in photometrically estimating the temperature by using it to obtain extinction of the field. Once for all approximate estimations of the temperature of the field might be made in terms of the resistance of the platinum strip, the variation of such resistance with rise of temperature being known. Such observations being made on a suitably protected strip might be compared with the wedge readings, the latter being then used for ready determinations. Want of time has hindered me from making such observation up to this.

The mineral to be experimented on is placed in small fragments near the centre of the platinum ribbon, and closely watched while the current is increased, till the melting point of the substance is apparent. Up to the present I have only used it comparatively, laying fragments of different fusibilities near the specimen. In this way I have melted beryl, orthoclase, and quartz. I was much surprised to find the last mineral melt below the melting-point of platinum. I have, however, by me as I write, a fragment, formerly clear rock-crystal, so completely fused that between crossed Nicols it behaves as if an amorphous body, save in the very centre where a speck of flashing colour reveals the remains of molecular symmetry. Bubbles have formed in the surrounding glass.